CHEMICAL HAZARD SUMMARY
Canadian Centre for Occupational Health and Safety
250 Main Street East
Hamilton Ontario Canada L8N 1H6

Malathion

(CAS 121-75-5)

No. 31
ISSN 0827-8830

SCOPE OF THE DOCUMENT

This document focuses on the hazards of malathion. The toxicity, flammability and reactivity of malathion are described. Details of first aid and exposure controls are also given. Information relevant to the workplace is emphasized. Special attention is given to the main hazard presented by malathion.

CONTENTS

I. MAIN HAZARD 1

II. OCCUPATIONAL EXPOSURE 1

III. HEALTH HAZARDS 1
- Removal from the Body 1
- Effects of Short-Term Overexposure in Humans 1
- Effects of Long-Term Overexposure in Humans 3
- Toxicity Data in Animals and Laboratory Tests 3

IV. FIRE AND EXPLOSION HAZARDS 4

V. CHEMICAL REACTIVITY HAZARDS 5

VI. EXPOSURE LIMITS 5

VII. EXPOSURE CONTROLS 5

VIII. STORAGE AND HANDLING 7

IX. FIRST AID 7

X. FIRE FIGHTING 8

XI. SPILL AND LEAK 8

XII. REFERENCES 9

I. MAIN HAZARD

Exposure to malathion can cause short-term effects on the nervous system.

II. OCCUPATIONAL EXPOSURE

Malathion is one of the most commonly used organophosphorous pesticides. It is one of the least toxic chemicals in this family. Introduced commercially in 1950, it is widely used on field crops, fruits and vegetables, livestock and in agricultural buildings. It is also used in domestic gardens and for controlling insects around the house.

Technical malathion, which is used for pest control, contains impurities such as isomalathion. These impurities make technical malathion more toxic than pure malathion[1]. The way in which technical malathion is made and stored determines the concentration of impurities present[2,3].

The toxicity of malathion can be changed by organic solvents used in the formulation. Malathion toxicity may be increased if used in combination with other insecticides[2]. This means that smaller amounts of it would cause poisoning.

Malathion can be absorbed in toxic amounts through the skin and possibly through the eyes. Evidence suggests skin contact presents the greatest danger to people exposed to malathion[4,5]. Breathing in the vapours, mists or dusts of malathion is also an important route of occupational exposure[4]. Swallowing of malathion is not common in the workplace but may occur if traces are present on hands, food, cigarettes or clothing.

General information on routes of exposure is available in the CCOHS publication "How Workplace Chemicals Enter the Body"[6].

III. HEALTH HAZARDS

Removal from the Body

Malathion is rapidly broken down, mostly by the liver. The breakdown products of malathion appear in the urine within a few hours of exposure. Most of these breakdown products are not very harmful, but one, called malaoxon, attacks an enzyme important for normal nerve function. It is thought that rapid breakdown and removal of malathion from the body is the reason for its low toxicity to humans.

Effects of Short-Term Overexposure in Humans

Cases of acute poisoning with malathion have occurred most often in agricultural workers during or shortly after spraying of crops. Poisoning is less common in workers exposed during manufacture, formulation or transportation of malathion[7].

High-level, short-term exposure to malathion poisons all parts of the nervous system. It can also affect many other parts of the body especially the lungs, heart and intestines. The disease is sometimes called Organophosphoric Syndrome[1,8]. The time interval between the exposure and the onset of symptoms varies with the route of exposure and degree of exposure. Usually, symptoms occur within 12 hours of exposure. Early symptoms may resemble the flu[9,10].

Table 1 summarizes the signs and symptoms of acute malathion poisoning[11].

Table 1
Acute Health Effects of Malathion

Mild/Moderate Poisoning

Dizziness
Headache
Tiredness
Blurred or darkened vision
Excessive sweating
Nausea
Vomiting
Increased salivation
Tears in the eyes

Severe Poisoning

Symptoms of mild/moderate poisoning as described above and:
Difficulty in walking or other muscular weakness
Tightness of the chest
Bluish skin
Twitching muscles and eyelids
Tiny pinpoint pupils in the eyes
Uncontrolled urination
Abdominal pain, cramps and diarrhea
Rapid heart beat
Slight or moderate increases in blood pressure

Very Severe Poisoning

Symptoms of mild/moderate and severe poisoning as described above and:
Difficulty in breathing
General seizures
Unconsciousness
Death

Inhalation
Symptoms depend on the degree of poisoning as shown in Table 1. In severe or moderately severe malathion poisoning, there may be rapid heart beat, paleness of the skin and slight to moderate increases in blood pressure.

Skin
Absorption of malathion through the skin can cause poisoning. Signs and symptoms are identical to those produced by inhalation. Skin irritation and allergies can also occur. These may be caused by solvents in the product rather than the malathion[12]; however, one report notes that 95% pure analytical grade malathion was a strong contact sensitizer in human volunteers[13].

Ingestion
After malathion is swallowed, there may be loss of appetite, nausea, vomiting, abdominal cramps and diarrhea within 2 hours[4]. Other symptoms are described in Table 1.

Effects of Long-Term Overexposure in Humans

The effects of low-level, long-term exposure to malathion are poorly studied. The information is limited and controversial.

Effects on the Nervous System
Headaches, giddiness, tiny pupils in the eyes and muscular weakness may be commonly experienced by workers exposed for long periods to malathion[14]. These effects are probably due to repeated short-term exposures rather than to any long-term disease.

Effects on the Skin
Repeated exposures may cause skin sensitization. If this happens, even low exposures cause skin inflammation.

Carcinogenic Effects
No reports suggest human cancer is associated with exposure to malathion.

Reproductive Hazards
There is no evidence that malathion causes fetal deformities in humans. No evidence suggests effects on reproductive function in humans.

Toxicity Data in Animals and Laboratory Tests

Lethal Dose Values
The poisoning strength of a compound can be estimated from the LD_{50} obtained in animal tests. LD stands for lethal dose. The LD_{50} is the amount of a chemical (weight of chemical per weight of animal) which is needed to kill one-half (50 percent) of the test animals. Test animals are usually rats, mice or other rodents. Routes of exposure are usually by mouth (oral), through the skin (dermal) or by breathing in the airborne chemical (inhalation). The values obtained for this material by different researchers are:

LD_{50} Value	99% Technical Malathion	90% Technical Malathion
LD_{50} (rat, oral)	4700-5843 mg/kg	940-1156 mg/kg[15]
LD_{50} (rat, oral)	1400-1845 mg/kg	390-480 mg/kg[15]
LD_{50} (rabbit, dermal)	Greater than 900 mg/kg[15]	
LD_{50} (rat, dermal)	Greater than 4400 mg/kg[17]	

The presence of impurities in the commercial product increases the toxicity of malathion. The 90% technical product has a greater concentration of impurities and is therefore more toxic.

On a scale of 1 to 6, where 1 is practically non-toxic and 6 is super toxic, the poisoning potential of the 90% technical grade rates as 3-4 (moderately to very toxic). The 99% grade rates as 2-3 (slightly to moderately toxic)[18].

Further general information on the LD_{50} is available in the CCOHS publication "What is an LD_{50}?"[19]

Other Animal Data/Carcinogenic Effects
The International Agency for Research on Cancer (IARC) has reviewed animal studies in which rats and mice were fed malathion. It concluded that there was no evidence of carcinogenicity[20]. Animal studies by the U.S. National Cancer Institute also concluded that malathion was not carcinogenic, but this conclusion has been questioned[16].

Other Animal Data/Reproductive Hazards
Studies in laboratory animals are widely used to indicate the potential of a chemical to cause reproductive effects in humans.

In one study, pregnant rats were fed very large quantities of malathion and produced newborn rats with low birth weights[21]. Also, there was an increase in the mortality of the newborns. In another study, large quantities of malathion were injected directly into pregnant rats and no effects were noted on the fetuses[22]. High doses of technical malathion 99% and 90% pure were fed to pregnant rats. Even though toxic impurities were present, no birth defects were noted[23].

IV. FIRE AND EXPLOSION HAZARDS

Malathion burns if strongly heated. The risk of fire is greatly increased if malathion comes into contact with strong oxidizers such as peroxides or chlorates. When heated, containers can explode. Vapours and fumes from fires involving malathion are toxic.

V. CHEMICAL REACTIVITY HAZARDS

Malathion is corrosive to iron, tin, steel, copper and lead. It reacts with magnesium. Contact with strong oxidizers such as peroxides or chlorates increases the risk of fire.

VI. EXPOSURE LIMITS

Many Canadian jurisdictions have exposure limits similar to those established by the American Conference of Governmental Industrial Hygienists (ACGIH). For malathion, ACGIH has established a threshold limit value - time-weighted average exposure (TLV-TWA) of 10 milligrams per cubic metre (mg/m^3).

Consult the appropriate authority in your jurisdiction for specific details.

VII. EXPOSURE CONTROLS

Engineering Controls
Engineering controls to reduce exposure are preferred. Such controls may be useful in processes involving the manufacture of malathion. Methods include process or personnel enclosure, control of process conditions and process modification. Other control methods such as administrative controls or the use of personal protective equipment may also be required.

Respiratory Protection
In manufacturing situations, appropriate respiratory equipment should be available for use in emergencies such as spills. For exposures during spraying procedures, work practices and suitable, approved personal protective equipment are essential to minimize exposures.

Institute a complete, continuing respiratory protection program including selection, fit, testing, training, maintenance, inspection, cleaning and evaluation. Refer to the CSA Standards Z94.4-M1982, "Selection, Care, and Use of Respirators."[25]

The following respiratory protection guidelines are recommended by the National Institute for Occupational Safety and Health (NIOSH)[26]*.

Particulate or vapour concentration of 150 milligrams per cubic metre (mg/m^3) or less:
Any supplied-air respirator, or
Any self-contained breathing apparatus, or
Any chemical cartridge respirator with organic vapour cartridge(s) in combination with a dust, mist and fume filter.

Particulate or vapour concentration of 375 mg/m^3 of less:
Any supplied-air respirator operated in a continuous-flow mode**, or
Any powered air-purifying respirator with organic vapour cartridge(s) in combination with a dust, mist and fume filter**.

Particulate or vapour concentration of 750 mg/m^3 or less:
Any supplied-air respirator with a full facepiece, or
Any self-contained breathing apparatus with a full facepiece, or
Any chemical cartridge respirator with a full facepiece and organic vapour cartridge(s) in combination with a high-efficiency particulate filter, or
Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapour canister having a high-efficiency particulate filter, or
Any powered air-purifying respirator with a tight-fitting facepiece and organic vapour cartridge(s) in combination with a high-efficiency particulate filter**, or
Any supplied-air respirator with a tight-fitting facepiece operated in a continuous-flow mode**.

Particulate or vapour concentration of 5000 mg/m^3 or less:
Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive-pressure mode.

Emergency or planned entry in unknown concentration or IDLH* conditions:**
Any self-contained breathing apparatus with full facepiece and operated in a pressure-demand or other positive-pressure mode, or
Any supplied-air respirator with a full facepiece and operated in pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode.

Escape
Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapour canister having a high-efficiency particulate filter, or
An appropriate escape-type self-contained breathing apparatus.

* The above recommendations apply only to equipment approved by NIOSH or MSHA.

** Eye protection may also be required.

*** IDLH: For the purposes of respiratory protection, the Immediately Dangerous to Life or Health (IDLH) is defined as the maximum concentration from which one could escape within 30 minutes without suffering any escape-impairing symptoms or irreversible health effects.

VIII. STORAGE AND HANDLING

Store malathion in its original sealed containers. Use lined containers because malathion reacts readily with metals, especially iron. Use well-ventilated, cool and dry store houses and shaded places for storage. Storage at high temperatures may change the concentration of impurities and increase the toxicity of malathion.

Provide emergency eye-wash fountains and safety showers near the work area. Train and inform workers of the hazards of malathion and safe work practices for pesticides.

IX. FIRST AID

Take proper precautions to ensure your own safety before attempting rescue. Wear appropriate protective equipment, use the "buddy" system.

Inhalation
Remove the source of contamination or move the person to fresh air. If breathing has stopped, have trained personnel begin artificial respiration or, if the heart has stopped, cardiopulmonary resuscitation (CPR) immediately. Keep the victim warm. Get medical attention as soon as possible.

Ingestion
Never give anything by mouth if the victim is losing consciousness, or is unconscious or convulsing. Have the victim rinse mouth with water. DO NOT INDUCE VOMITING. Have the victim drink about 250 mL (8 oz) of water. If vomiting occurs naturally, rinse mouth and repeat administration of water. Begin artificial respiration if not breathing. Give CPR if the heart has stopped.

Eyes
If malathion or formulations containing malathion get into the eyes, flush the eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If available, a neutral saline solution may be used to irrigate the eyes until medical assistance is provided. Obtain medical attention immediately.

Skin
Promptly wash the contaminated skin using soap or mild detergent in running water. Remove contaminated clothing. Protect the eyes and uncontaminated skin. Obtain medical attention immediately.

General Comments
All first aid procedures should be periodically reviewed by a physician familiar with the material and its conditions of use in the workplace. Specific antidotes for malathion poisoning are available but must be administered by a physician.

X. FIRE FIGHTING

Fire Extinguishing Agents
For fires involving malathion, use dry chemical, carbon dioxide, water spray and foam extinguishers[24].

The flash point of a chemical is an important indicator of its flammability[24]. When the material is at or above this temperature, enough vapour is produced to form a flammable mixture of vapour and air. An ignition source will cause this mixture to burn. The flash point of malathion is relatively high 162°C (325°F); however, the solvents with which it is formulated and used have much lower flash points and may present a fire hazard.

XI. SPILL AND LEAK

Precautions
Restrict access to the spill area until clean-up is completed. Ensure the clean-up is conducted by trained personnel wearing appropriate protective equipment. Provide adequate ventilation. In many cases, spilled malathion can be decontaminated with bicarbonate of soda and liquid chlorine bleach added to water in a plastic container. Decontamination may take several washes. Consult the material safety data sheet or supplier for details.

Disposal
Spills can be collected for reclamation or absorbed in vermiculite, dry sand, earth or similar material. Review federal, provincial, territorial and local government requirements prior to disposal. Never discharge malathion directly into sewers or streams.

XII. REFERENCES

(1) Hayes, W.J., Jr. Pesticides studied in man. Baltimore : Williams & Wilkins, 1982. p. 333-339

(2) World Health Organization study group. Recommended health-based limits in occupational exposure to pesticides : malathion. Geneva : World Health Organization, 1982. p. 13-38

(3) Occupational health guidelines for chemical hazards : malathion. Cincinnati : U.S. National Institute for Occupational Health and Safety, 1981. p. 815-819

(4) Criteria for a recommended standard ... occupational exposure to malathion (NIOSH 76-205). Cincinnati : U.S. National Institute for Occupational Health and Safety, 1976

(5) Ontario task force on health and safety in agriculture. Agricultural chemicals and farm health and safety (background paper #3). Toronto : Ontario Ministries of Agriculture and Food and Labour, 1984. p. 39-45

(6) Halton, D.M. How workplace chemicals enter the body. Hamilton, Ont. : CCOHS, 1985

(7) Hayes, W.J., Jr. Clinical handbook on economic poisons – emergency information for treating poisoning. Atlanta : U.S. Department of Health, Education, and Welfare. Communicable Disease Centre, 1963. p. 12-23

(8) Baker, E.L., Jr.; Zack, M.; Miles, J.M.; et al. Epidemic malathion poisoning in Pakistan malaria workers. Lancet. Vol. 1 (1978). p. 31-34

(9) Namba, T.; Nolte, C.T.; Jackrel, J.; Grob, D. Poisoning due to organophosphate insecticides : acute and chronic manifestations. American Journal of Medicine. Vol. 50 (1971). p. 475-492

(10) Karczmar, A.G. Acute and long lasting central actions of organophosphorus agents. Fundamental and Applied Toxicology. Vol. 4, no. 2, part 2 (1984). p. S1-S17

(11) Warren, M.; Spencer, H.C.; Churchill, F.C.; et al. Assessment of exposure to organophosphate insecticides during spraying in Haiti : monitoring of urinary metabolites and blood cholinesterase levels. WHO Bulletin. Vol. 63, no. 2 (1985). p. 353-360

(12) Wester, R.C.; Maibach, H.I.; Bucks, D.A.W.; Guy, R.H. Malathion percutaneous absorption after repeated administration to man. Toxicology and Applied Pharmacology. Vol. 68 (1983). p. 116-119

(13) Milby, T.H.; Epstein, W.L. Allergic contact sensitivity to malathion. Archives of Environmental Health. Vol. 9 (1964). p. 434-437

(14) Kogure, M.; Imai, H. Ocular symptoms induced by organic phosphorus insecticides. Journal of the American Medical Women Association. Vol. 30, no. 10 (1975). p. 420-422

(15) Registry of toxic effects of chemical substances – on-line. 1986

(16) Reuber, M.D. Carcinogenicity and toxicity of malathion and malaoxon. Environmental Research. Vol. 37 (1985). p. 119-153

(17) Deroche, R. Organophosphorus pesticides. Criteria (dose/effect relationships) for organophosphorus pesticides. Toronto : Commission of the European Communities, Pergamon Press, 1977. p. 51

(18) Gosselin, R.E.; Smith, R.P.; Hodge, H.C. Clinical toxicology of commercial products. 5th ed. Baltimore : Williams & Wilkins, 1984

(19) Bello, S.J.; Halton, D.M. What is an LD_{50}? Hamilton, Ont. : CCOHS, 1986

(20) IARC monographs on the evaluation of the carcinogenic risk of chemical to humans. Vol. 30 : miscellaneous pesticides. Lyon : International Agency for Research on Cancer, 1983. p. 104-129

(21) Kalow, W.; Marton, A. Second generation toxicity study of malathion in rats. Nature (London). Vol. 192 (1961). p. 464-465

(22) Kimbrough, R.D.; Gaines, T.B. Effect of organic phosphorus compounds and alkylating agents on the rat fetus. Archives of Environmental Health. Vol. 16 (1968). p. 805-808

(23) Khera, K.S.; et al. Teratogenicity studies on linuron, malathion and methoxychlor in rats. Toxicology and Applied Pharmacology. Vol. 45 (1978). p. 435-444

(24) Weiss, G. Hazardous chemicals data book. 2nd ed. Park Ridge, N.J. : Noyes Data Corporation, 1986. p. 645

(25) Selection, care, and use of respirators (Z94.4-M1982). Rexdale, Ont. : Canadian Standards Association, 1982

(26) NIOSH pocket guide to chemical hazards. Cincinnati : National Institute for Occupational Safety and Health, 1985

Note: Additional references on this subject are available from CCOHS upon request.

PLEASE NOTE

Each document produced by the Centre undergoes several stages of review. As a part of this review, representatives from each of government, employers, and labour are requested to comment on draft copies of CCOHS documents for technical accuracy and readability.

Although every effort is made to ensure accuracy and completeness of the information, it is understood that the Centre makes no warranty as to the accuracy or completeness of such information and assumes no liability for any damages or loss suffered as a result of any inaccuracy or incompleteness therein.

This summary was prepared at the Canadian Centre for Occupational Health and Safety (CCOHS) and is intended primarily as a source of information for persons who work with or may be occupationally exposed to this material. The information selected for inclusion is believed to be reliable and generally relevant to occupational health. Other information may be available which bears on particular work situations. The scientific data in many areas are limited and may allow a variety of interpretations. Additional information, corrections, comments and questions are welcome, and should be addressed to the Inquiries Service, CCOHS, 250 Main Street East, Hamilton, Ontario, L8N 1H6, (416) 572-2981; toll free 1-800-263-8276.

The information in this document was updated on January 8, 1987.

Cat. No. CC273-4/87-11E
ISBN 0-660-12628-1
CCOHS C87-11E